M4G group (1)
Application Note
Real Time Clock
(RTC-A)

Outlines

This application note is a reference material for developing products using the real time clock (RTC) function of M4G group (1).
This document helps the user check operation of the product and develop its program.

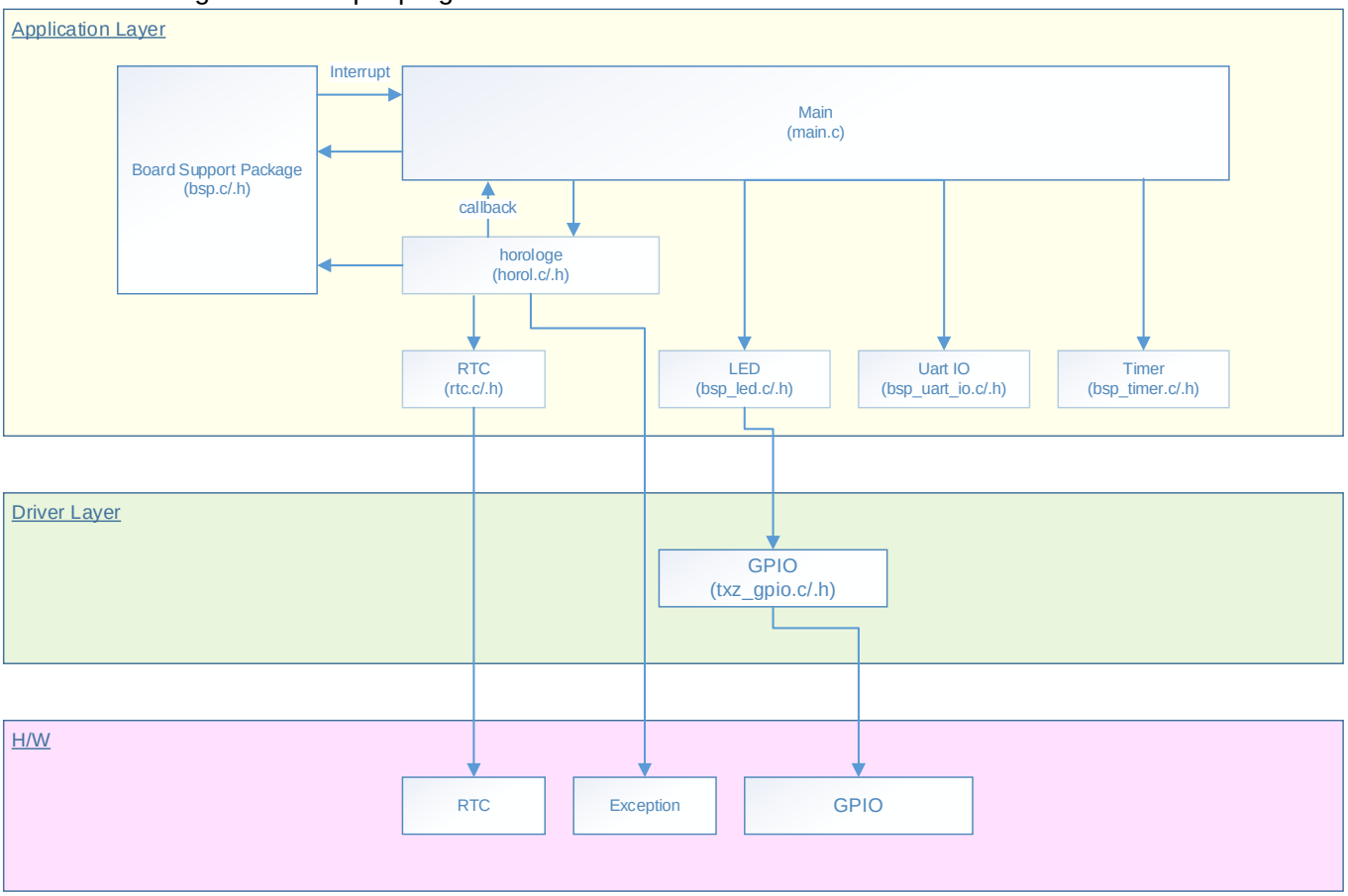
Target sample program: RTC_UART_LED

Table of Contents

1. Preface

This sample program is for checking the operation of RTC clock function
The date and time will be displayed on the terminal software on the host PC via USB-UART.

Structure diagram of Sample program



2. Reference Document

- Datasheet
  TMPM4G Group (1) datasheet Rev1.0 (Japanese edition)
- Reference manual
  Real Time Clock (RTC-A) Rev2.1 (Japanese edition)
  Asynchronous Serial Communication Circuit (UART-C) Rev3.0 (Japanese edition)
  Input and Output Ports (PORT-M4G(1)) Rev.1.0(Japanese edition)
- Application note
  M4G Group (1) Application Note Startup (CMSIS System &Clock Configuration) Rev1.0
- Other reference document
  TMPM4G (1) Group Peripheral Driver User Manual (Doxygen)

3. Function to Use

IP	Channel	Port	Function/Operation mode
Real Time Clock	-	-	Clock function
Asynchronous Serial Communication Circuit	ch0	PE2 (UT0RXD) PE3 (UT0TXDA)	UART mode
Input and Output Ports	-	PE4 (Output Port)	Output

4. Target Device

The target devices of this application note are as follows;

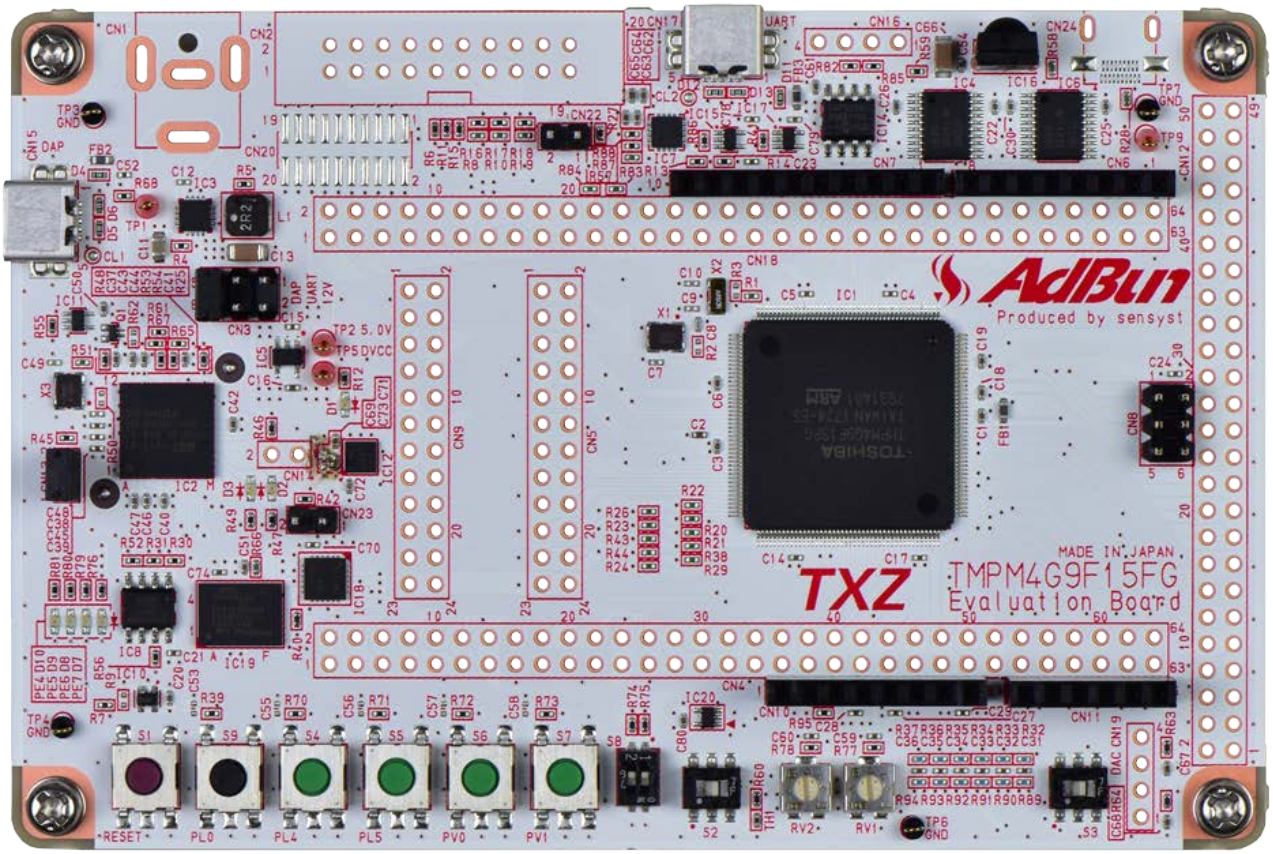
TMPM4G9F15FG	TMPM4G9F10FG	TMPM4G9FEFG	TMPM4G9FDFG
TMPM4G9F15XBG	TMPM4G9F10XBG	TMPM4G9FEXBG	TMPM4G9FDXBG
TMPM4G8F15FG	TMPM4G8F10FG	TMPM4G8FEFG	TMPM4G8FDFG
TMPM4G8F15XBG	TMPM4G8F10XBG	TMPM4G8FEXBG	TMPM4G8FDXBG
	TMPM4G7F10FG	TMPM4G7FEFG	TMPM4G7FDFG
	TMPM4G6F10FG	TMPM4G6FEFG	TMPM4G6FDFG

*This sample program operates on the evaluation board of TMPM4G9F15FG.
If other function than the TMPM4G9F15 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.
The BSP related file is dedicated to the evaluation board (TMPM4G9F15). If other function than the TMPM4G9F15 one is checked, the BSP related file should be changed properly.

5. Operation confirmation condition

Used microcontroller	TMPM4G9F15FG
Used board	TMPM4G9F15FG Evaluation Board by Sensyst
Unified development environment	IAR Embedded Workbench for ARM 8.11.2.13606
Unified development environment	µVision MDK Version 5.24.2.0
Terminal software	TeraTerm V4.96
Sample program	V1000

Evaluation board (TMPM4G9F15FG Evaluation Board) Top view

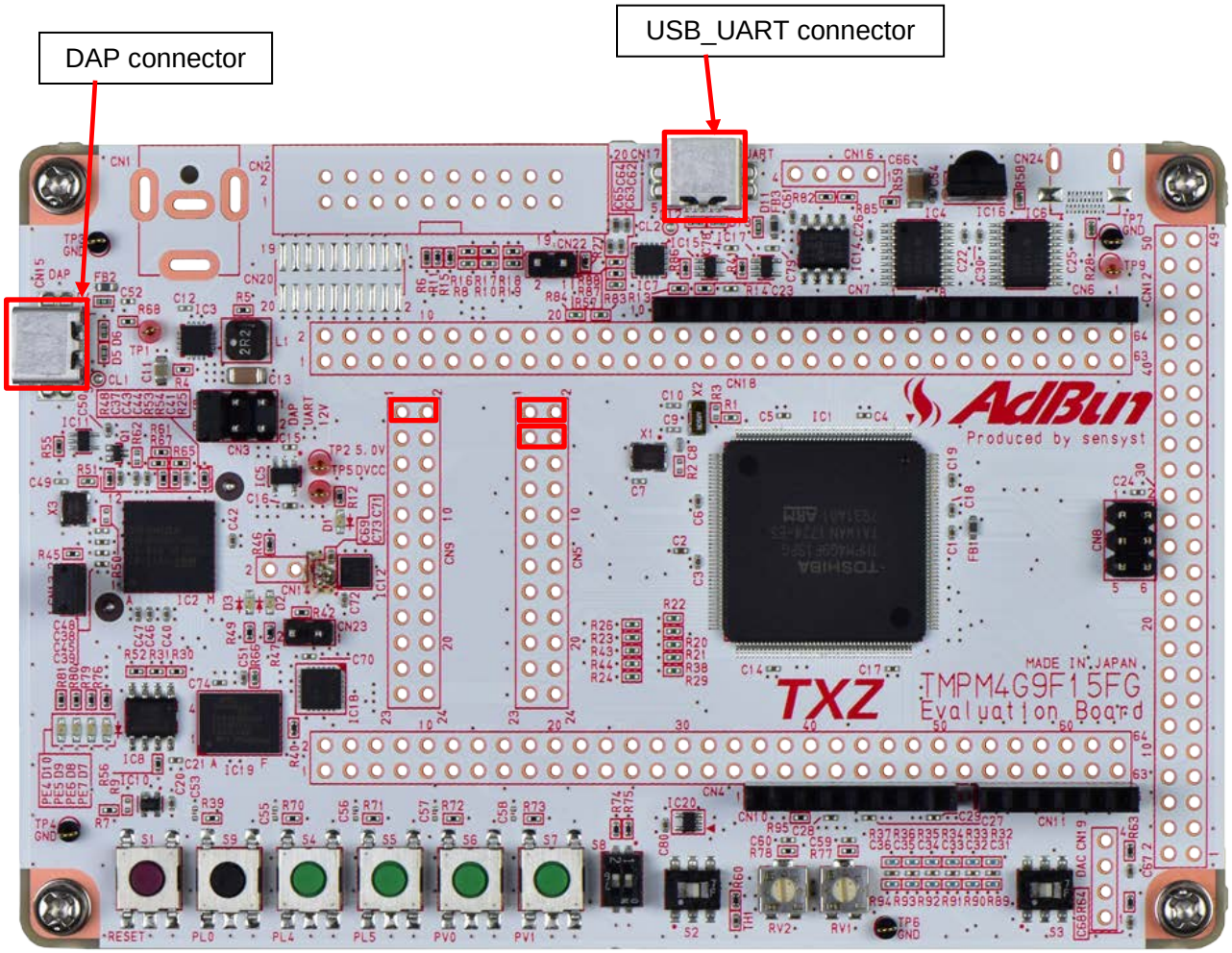


6. Evaluation Board Setting

The following pin connections should be done on the evaluation board.

CN5		
Board function	Through-hole No.	Through-hole No.
USB UART conversion	1: USB_UT_RX	2: PE2
USB UART conversion	3: USB_UT_TX	4: PE3

CN9		
Board function	Through-hole No.	Through-hole No.
LED (D10)	1: LED0	2: PE4



7. Operation of Evaluation Board

PC and the USB_UART are connected for communication with the terminal software.
After the start of RTC, date and time are displayed in terminal software.
The sample program starts from 2017-01-01 00:00:00.

8. Outline of RTC Function

The real time clock (RTC) is a clock function to which even the calendar corresponding to a leap year can respond. At counting a low speed clock (fs), a 1Hz clock is generated and it operates. Clock correction function can adjust clock progress and delay due to low speed oscillator error. The alarm function can output a pulse from ALARM_N pin or output an interrupt request by detecting coincidence of the time and the clock which was set up beforehand.

Since the RTC operates with a low speed clock, it can operate during Low Power Consumption modes, such as IDLE, STOP1, and STOP2. Moreover, it can be made to return from a Low Power Consumption mode using the interrupt request of RTC.

Functional outline

Function classification	Function	A Functional Description or the range
Clock function	Clock source	Low speed clock (32.768 kHz)
	Clock	Respond to hour, minute and second. Selectable 12(am/ pm) and 24 hour display.
	Calendar	Respond to date, a day of the week, month, year and leap year.
Alarm function	Alarm	It can set up minute, hour, a day of the week, and a day.
	Interruption	An INTRTC interrupt request is output when the clock matches the date and time of the alarm register.
	Pulse output	Pulse is output from the ALARM_N terminal when the clock matches the date and time of the alarm register. (Note)
Periodic interruption function	Interruption	An INTRTC interrupt request is outputted to the frequency of 1Hz, 2Hz, 4Hz, 8Hz and 16Hz.
	Pulse output	The pulse is outputted to frequency 1Hz, 2Hz, 4Hz, 8Hz and 16Hz. from an ALARM_N pin. (Note)
Other functions	Clock correction	Correction-reference time: Select from 1, 10, 20, 30 seconds or 1 minute. Correction value: +255 to -256
	Protection of a clock correction functional register	A correction functional control register ***[RTCADJCTL]***, a correction value register ***[RTCADJDAT]***, and the correction value sign register ***[RTCADJSIGN]*** can be protected from writing by a protection register ***[RTCPROTECT]***.
	1Hz clock output	1Hz clock (duty 50%) is output from the RTCOUT pin.(Note)
	Reset register	A second counter and an alarm register are initialized.

Note: There are built-in products and a non-built-in product with a RTCOUT pin and an ALARM_N pin. Please refer to the reference manual "Product Information" for details.

9. Sample Program

The sample program displays year / month / date and time in terminal software.
The sample program uses 2 Hz interrupt and clock function.
Time information is displayed on the terminal software via USB-UART.
The LED blinks at the same timing of the display timing of the terminal software.

9.1. Initialization

The following initialization is done after power is supplied.
The initialization of each clock setting and the setting of the watchdog timer are done.

9.2. Sample Program Main Operation–

After initialization, the following operations are done in the “main” function.
(1) BSP (Board Support Package) initialization
(2) Driver initialization
(3) Application initialization

After the settings are done, the RTC starts.
Initial value: 2017-01-01, 00:00:00
The display to the terminal software is done by the 2-Hz interrupt of the RTC.
The display to the terminal software is done every even count of the interrupt. So the display value is updated every 1 second.
The LED (D10) repeats lighting and lights-off every 500ms (500-ms lighting and 500-ms lights-off) using the 2-Hz interrupt.

9.3. Setting Modification of Displayed Time Information

When the time information is changed, the setting values in RTC: main.c should be modified.

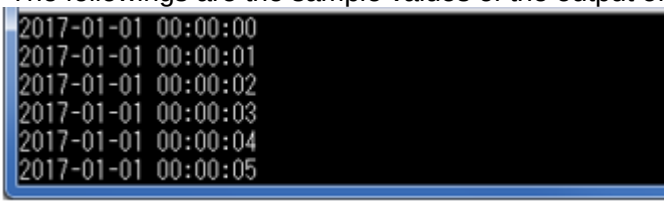
Item	Modified location	Note
CFG_HOROL_HOUR_NOTATION	(RTC_HOUR_NOTATION_24)	24-hour display setting
CFG_HOROL_CENTURY	((uint8_t)21)	Year setting
CFG_HOROL_YEAR	((uint8_t)17)	Setting of 2 least significant digits of the year
CFG_HOROL_MONTH	(RTC_MONTH_JAN)	Month setting
CFG_HOROL_DATE	((uint8_t)1)	Date setting
CFG_HOROL_DAY	(RTC_DAY_SUNDAY)	Day setting
CFG_HOROL_MERIDIEM	(RTC_MERIDIEM_AM)	AM/PM setting
CFG_HOROL_HOUR	((uint8_t)0)	Hour setting
CFG_HOROL_MIN	((uint8_t)0)	Minute setting
CFG_HOROL_SEC	((uint8_t)0)	Second setting

The initial values of the time has been set to 2017-01-01 00:00:00 in this sample program.
Any time values can be set by modifying each item value.

For the modification conditions and the range of each item value, refer to “bsp_rtc.h” file.
The modification range of each item is set.

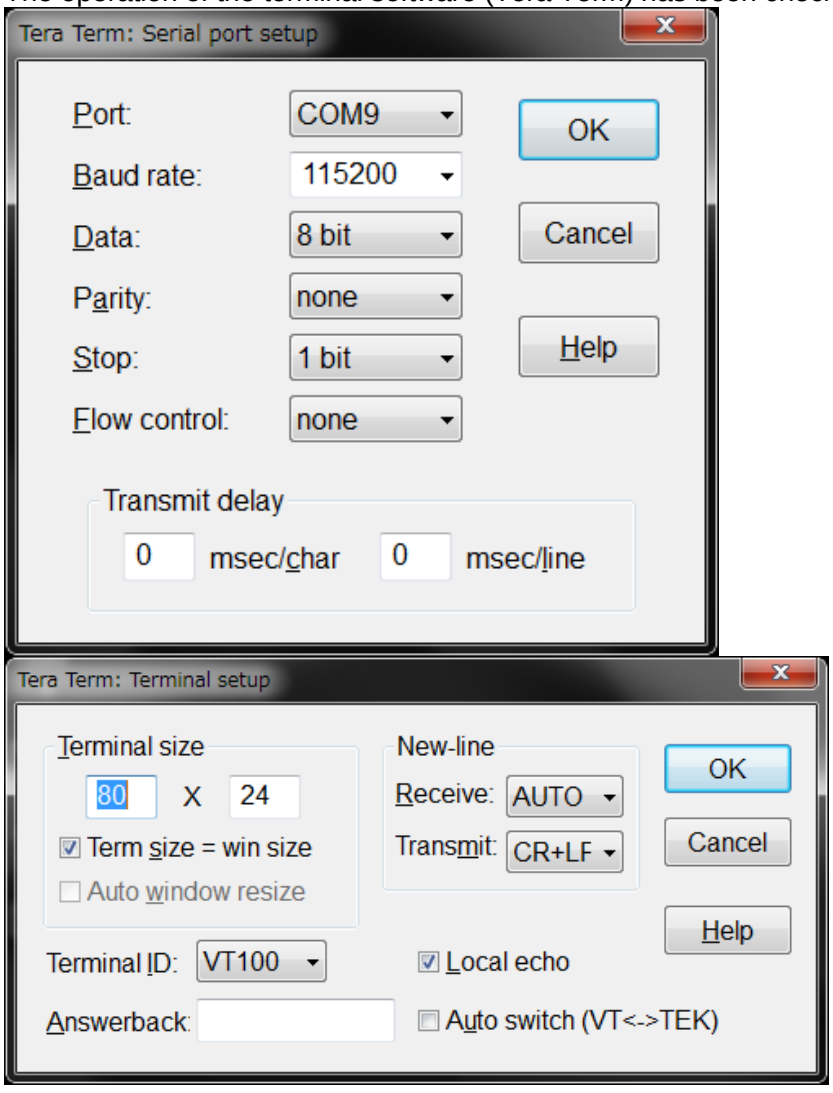
9.4. Output Example of Sample Program

When this sample program operates, the content in the clock register is displayed, as shown in the following figure.
The followings are the sample values of the output of the default setting state.



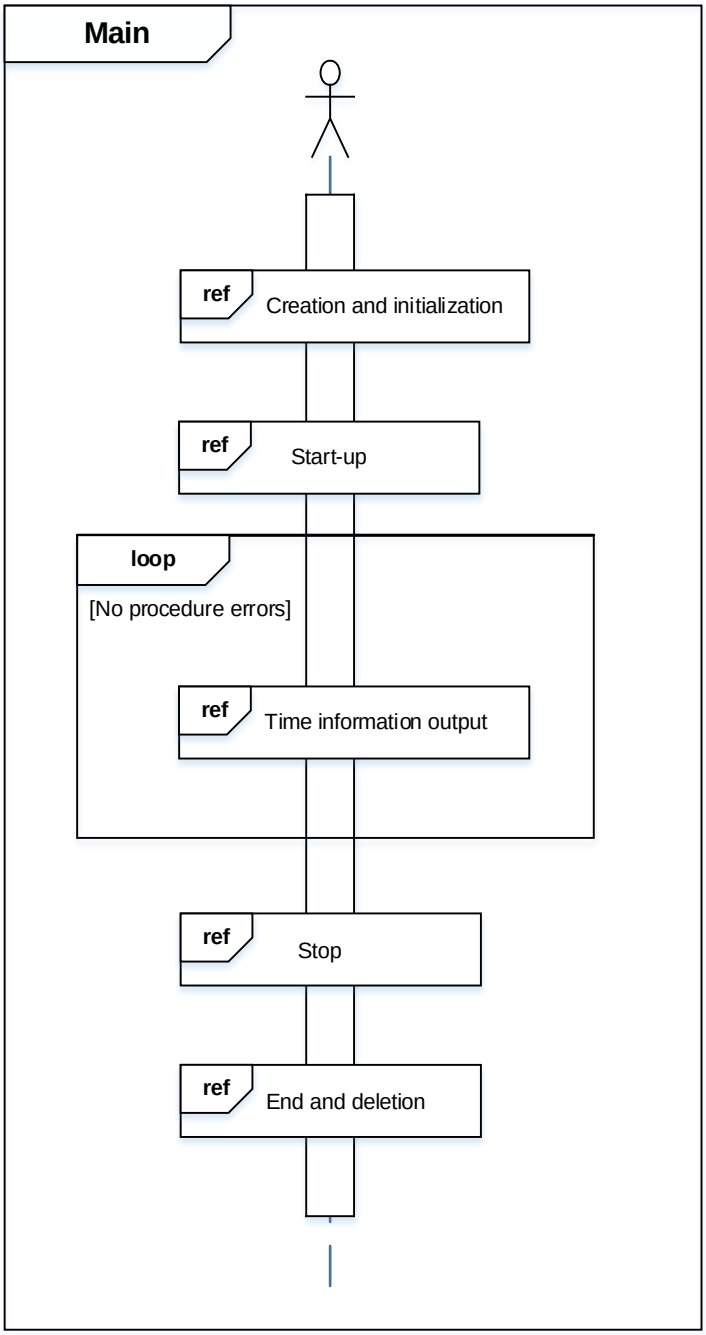
9.4.1. Setting Example of Terminal Software

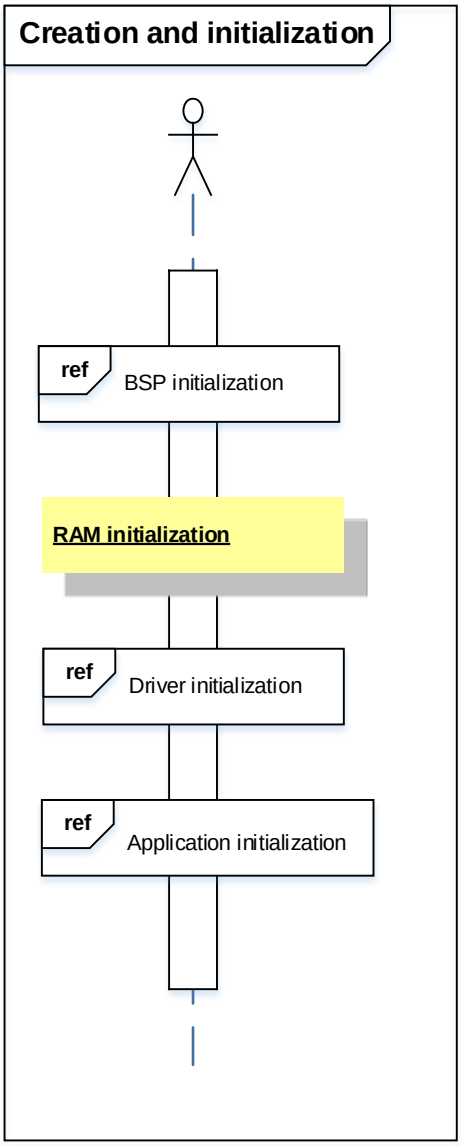
The operation of the terminal software (Tera Term) has been checked with the following settings.

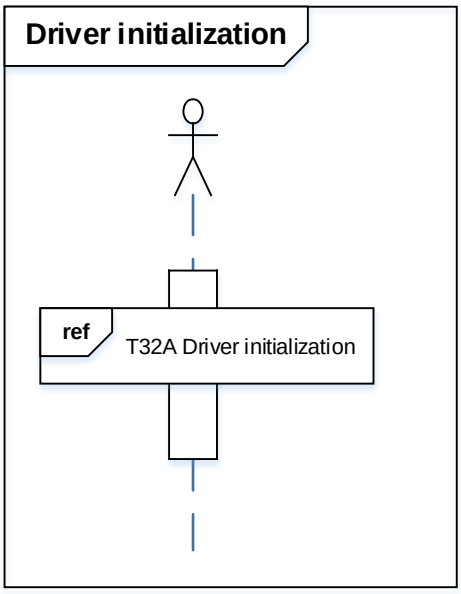


9.5. Operating Flow of Sample Program

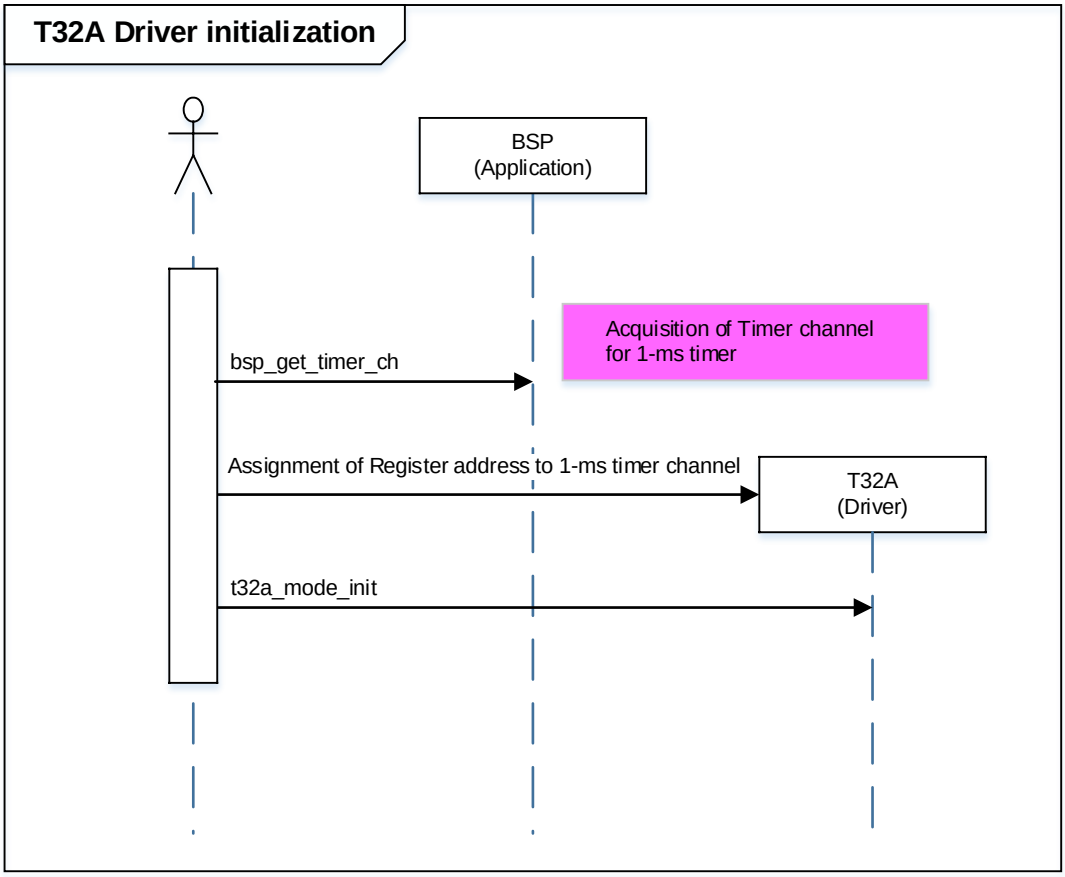
The basic operating flows of the sample program are shown in the following;

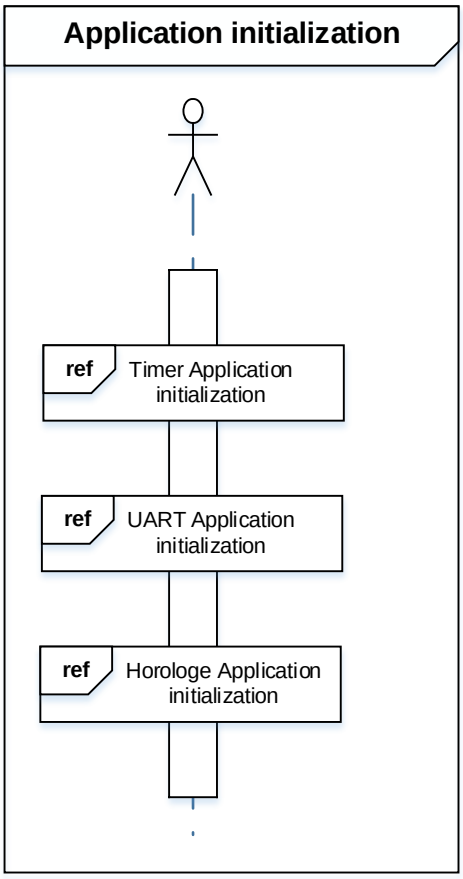


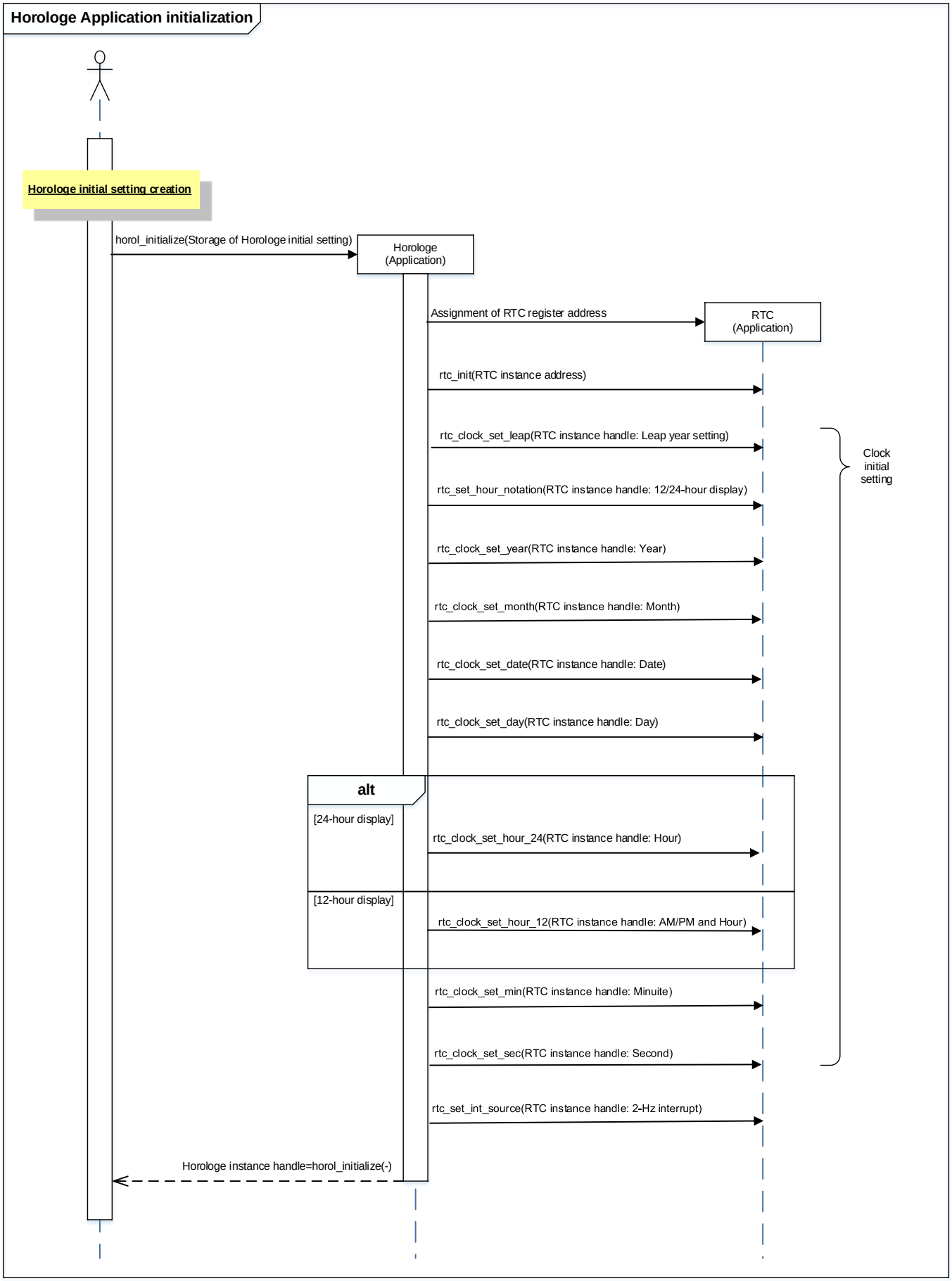

Creation and initialization
ref
BSP initialization
RAM initialization
ref
Driver initialization
ref
Application initialization

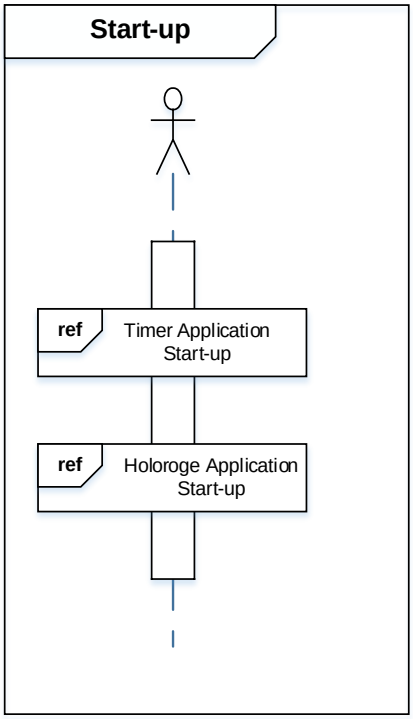

Driver initialization
ref
T32A Driver initialization

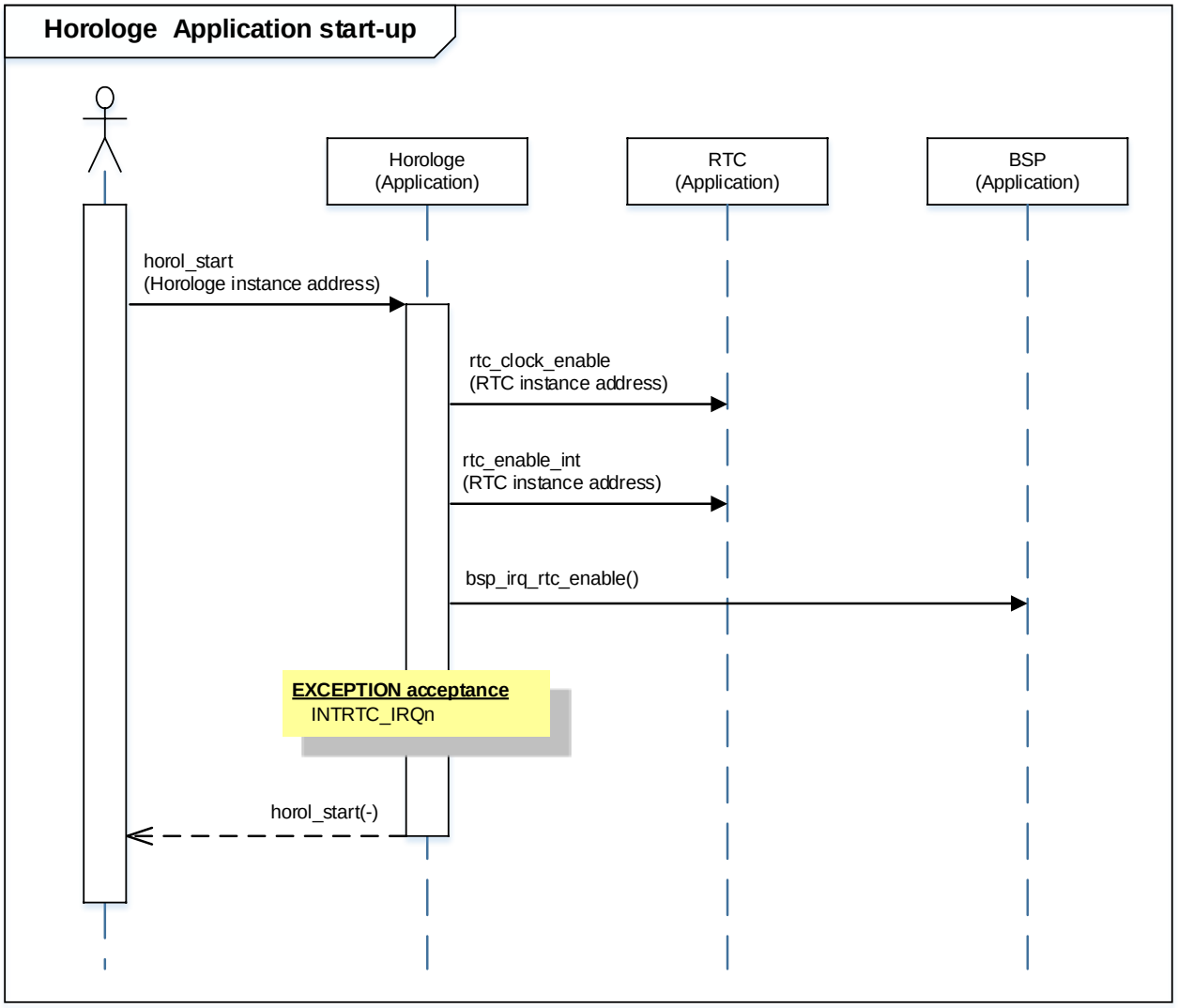
The 32-bit timer event counter of TMPM4G9 is running, but processing using timer count is not performed.

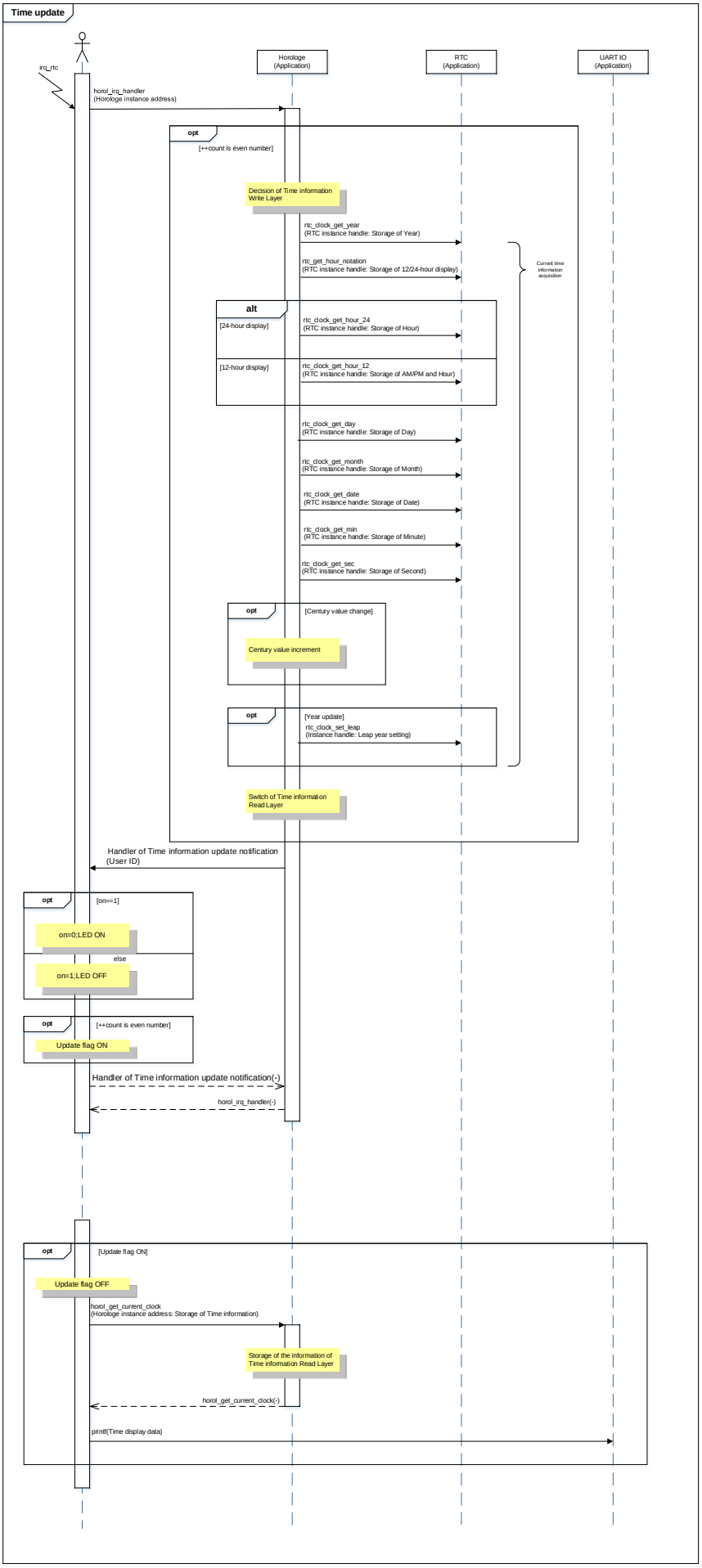


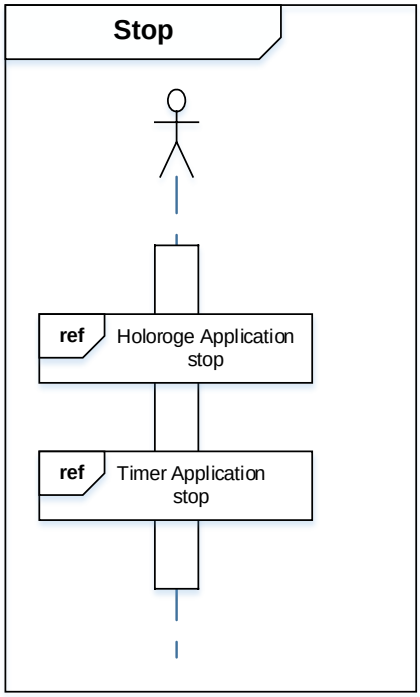


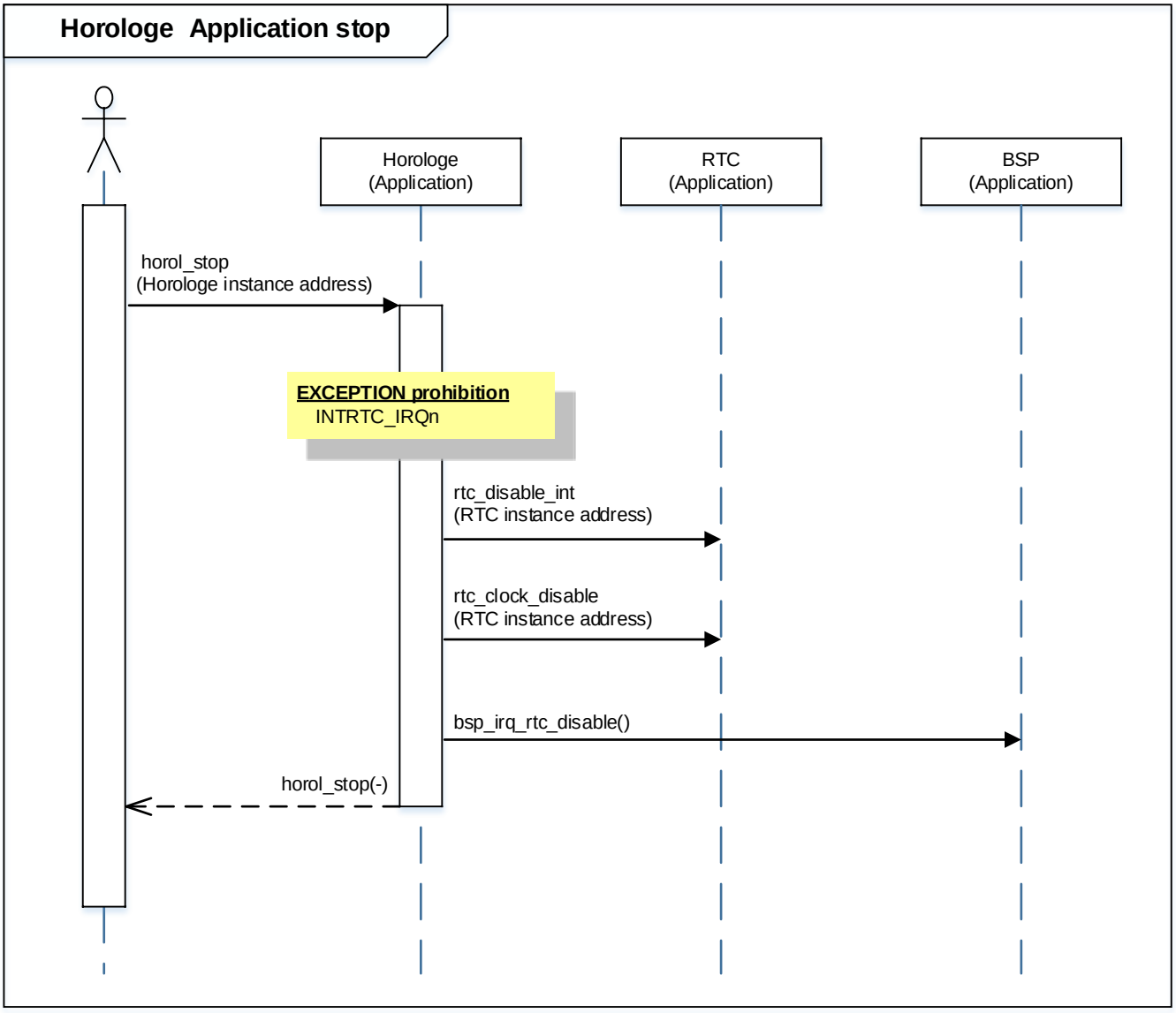

Horologe Application initialization
Horologe initial setting creation
horol_initialize(Storage of Horologe initial setting)
Horologe (Application)
Assignment of RTC register address
RTC (Application)
rtc_init(RTC instance address)
rtc_clock_set_leap(RTC instance handle: Leap year setting)
Clock initial setting
rtc_set_hour_notation(RTC instance handle: 12/24-hour display)
rtc_clock_set_year(RTC instance handle: Year)
rtc_clock_set_month(RTC instance handle: Month)
rtc_clock_set_date(RTC instance handle: Date)
rtc_clock_set_day(RTC instance handle: Day)
alt
[24-hour display]
rtc_clock_set_hour_24(RTC instance handle: Hour)
[12-hour display]
rtc_clock_set_hour_12(RTC instance handle: AM/PM and Hour)
rtc_clock_set_min(RTC instance handle: Minuite)
rtc_clock_set_sec(RTC instance handle: Second)
rtc_set_int_source(RTC instance handle: 2-Hz interrupt)
Horologe instance handle=horol_initialize(-)

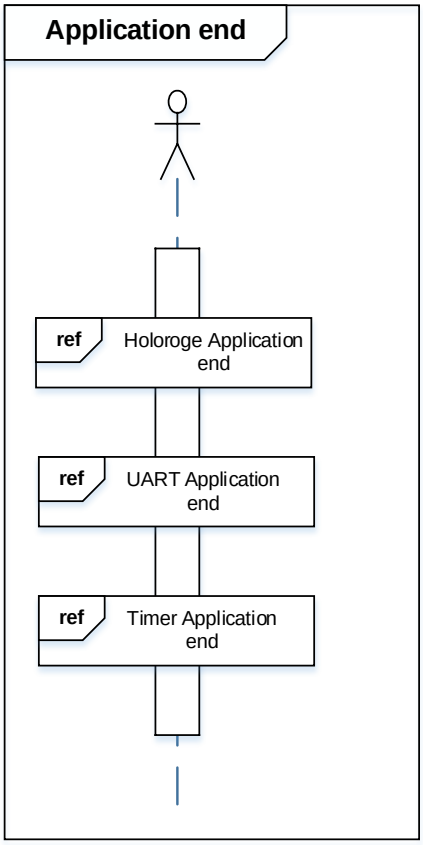

Start-up
ref
Timer Application
Start-up
ref
Holoroge Application
Start-up

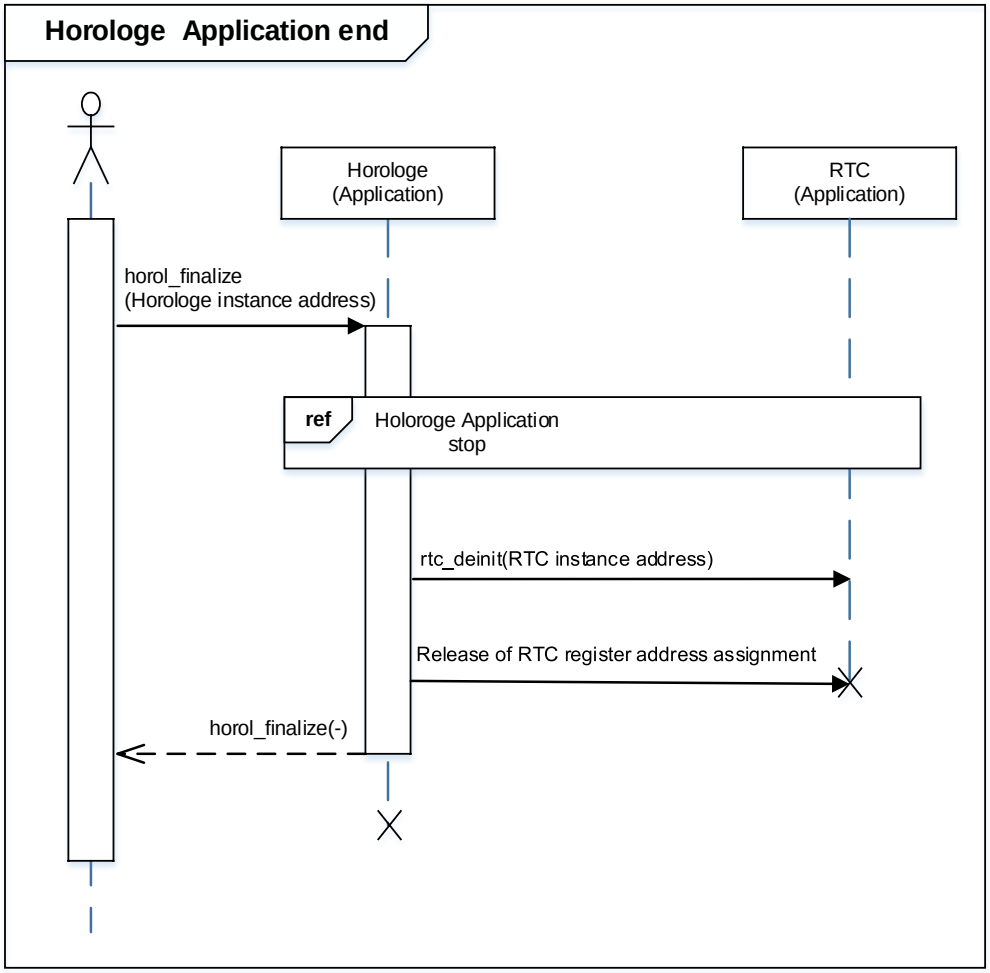

Horologe Application start-up
Horologe
(Application)
RTC
(Application)
BSP
(Application)
horol_start
(Horologe instance address)
rtc_clock_enable
(RTC instance address)
rtc_enable_int
(RTC instance address)
bsp_irq_rtc_enable()
EXCEPTION acceptance
INTRTC_IRQn
horol_start(-)

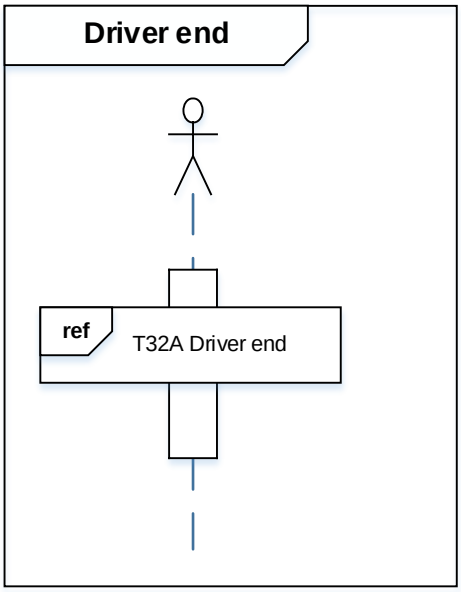

Time update
irq_rtc
Horologe (Application)
RTC (Application)
UART IO (Application)
horol_irq_handler (Horologe instance address)
opt
[++count is even number]
Decision of Time information Write Layer
rtc_clock_get_year (RTC instance handle: Storage of Year)
rtc_get_hour_notation (RTC instance handle: Storage of 12/24-hour display)
Current time information acquisition
alt
[24-hour display]
rtc_clock_get_hour_24 (RTC instance handle: Storage of Hour)
[12-hour display]
rtc_clock_get_hour_12 (RTC instance handle: Storage of AM/PM and Hour)
rtc_clock_get_day (RTC instance handle: Storage of Day)
rtc_clock_get_month (RTC instance handle: Storage of Month)
rtc_clock_get_date (RTC instance handle: Storage of Date)
rtc_clock_get_min (RTC instance handle: Storage of Minute)
rtc_clock_get_sec (RTC instance handle: Storage of Second)
opt
[Century value change]
Century value increment
opt
[Year update]
rtc_clock_set_leap (Instance handle: Leap year setting)
Switch of Time information Read Layer
Handler of Time information update notification (User ID)
opt
[on==1]
on=0;LED ON
else
on=1;LED OFF
opt
[++count is even number]
Update flag ON
Handler of Time information update notification(-)
horol_irq_handler(-)
opt
[Update flag ON]
Update flag OFF
horol_get_current_clock (Horologe instance address: Storage of Time information)
Storage of the information of Time information Read Layer
horol_get_current_clock(-)
printf(Time display data)

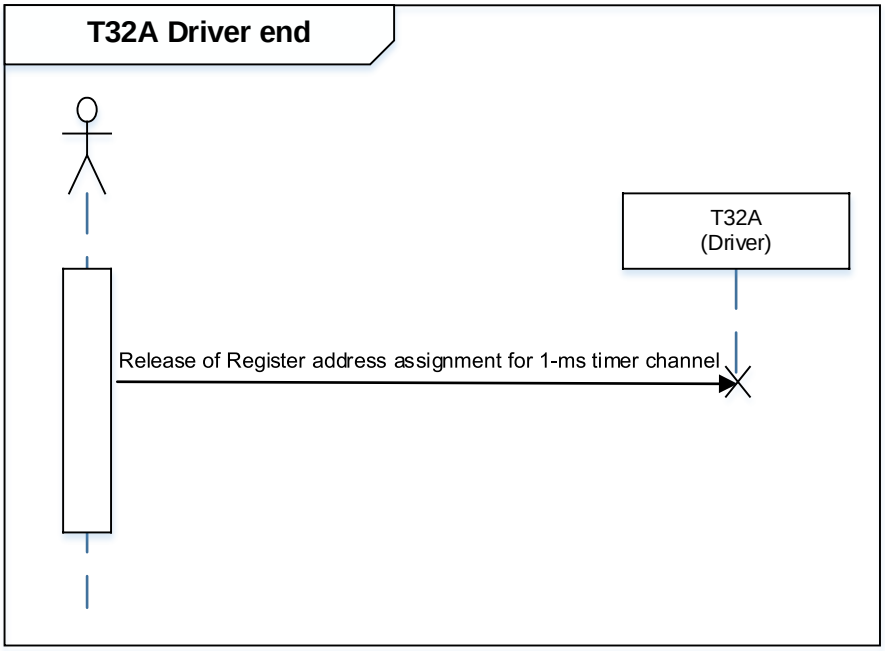

Stop
ref
Holoroge Application stop
ref
Timer Application stop

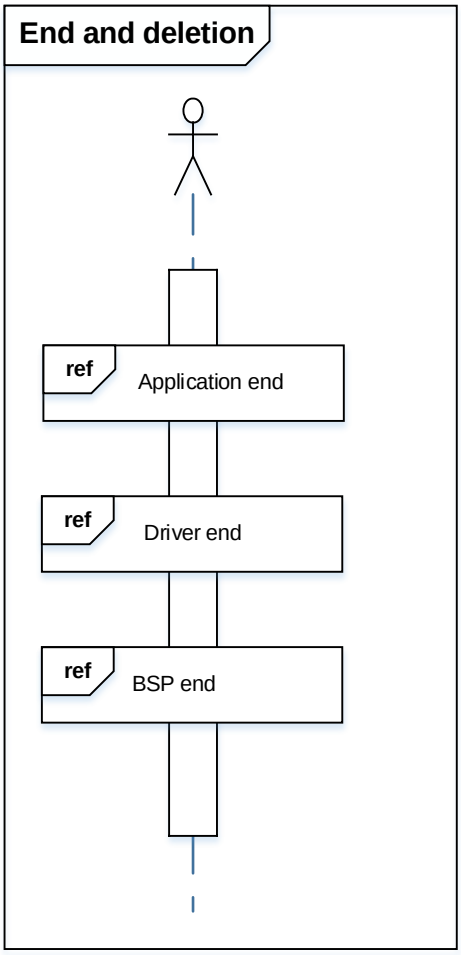

Horologe Application stop
Horologe (Application)
RTC (Application)
BSP (Application)
horol_stop (Horologe instance address)
EXCEPTION prohibition
INTRTC_IRQn
rtc_disable_int (RTC instance address)
rtc_clock_disable (RTC instance address)
bsp_irq_rtc_disable()
horol_stop(-)


Application end
ref
Holoroge Application end
ref
UART Application end
ref
Timer Application end


Horologe Application end
Horologe (Application)
RTC (Application)
horol_finalize (Horologe instance address)
ref
Holoroge Application stop
rtc_deinit(RTC instance address)
Release of RTC register address assignment
horol_finalize(-)


Driver end
ref
T32A Driver end


T32A Driver end
T32A
(Driver)
Release of Register address assignment for 1-ms timer channel


End and deletion
ref
Application end
ref
Driver end
ref
BSP end

10. Precaution

When using the sample program with CPU other than TMPM4G9F15, please check operation sufficiently.

11. Revision History

Rev	Date	Description
1.0	2018-12-14	First release

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